Evaluatıon of some parameters affectıng embroıdery qualıty

Fatih Emekli, MScEng
Prof. **Zümrüt Bahadır Ünal,** PhD
Ege University
Department of Textile Engineering
İzmir, Turkey
e-mail: zumrut.bahadir.unal@ege.edu.tr
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Embroidery is an important work step in Textile and Apparel sector, because it affects directly the appearance and the costs of both visually and the design and application process. This study offers generally information on embroidery first. Factors influencing the quality of embroidery applied to textiles and garments have been identified and these factors have been evaluated practically with a standard embroidery type. As a result, heat and water-soluble interlinings may be suitable for embroidery with large areas that are undesirable to be thick and heavy. Interlinings that cannot be completely removed from the embroidered area can be used for small embroidered areas such as the brand logo.

Keywords*: embroidery, embroidery parameters, interlining, machine set up*

1. Introduction

The art of ornamentation is all kinds of arts that is made with the aim of giving to give an object or structure a more beautiful appearance, to enhance its allure and to increase its value. The art of ornamentation has been an important part of traditional Turkish culture and art for many centuries. Carried from Central Asia to Anatolia, the art of ornamentation has gained great importance in the Seljuk and Ottoman periods and reached the Republic period with the accumulation of centuries. The most important kinds of ornament art are gilding, paper marbling, miniature, relief ceramic, porcelain, stone, marble, wood, and texture and embroidery arts.

Embroidery is an ornament form obtained by processing many figures of living, inanimate or geometrical figures on the floor of different objects for decoration purposes. Its history dates back to very ancient years. It has been noticed that various painting methods and processing techniques have been applied in the garments, covers, felts and fabrics at the excavations in the Altai Mountains where the Huns lived. In the period from the collapse of the Hun Empire and to the settlement of Turks to Anatolia, it is seen that the ornamentation survived its presence from the decoration of clothes according to Göktürk writings and in the Uyghur wall paintings (1). In the period of Ottoman Empire, Turkish embroidery reached its most brilliant period. The embroideries were made not only in the palace but also in every part of the people outside the palace [1].

Although the aim of embroidery is to bring people's patterns and thematic elements into social life for centuries; today, it is to be adapted to fashion, to increase the attractiveness and value of the product.

The use of embroidery is quite common. Embroidery is used in garments, accessories, home textiles and decorative products. The embroidery process is an industry in the world and is a sub-sector in the textile sector. Although it is not very high in cost, it provides a high added value to textile products.

Embroidery design has a great role in the formation of good embroidery in the textile sector. Therefore, the de-

sign process is difficult and skillful. The necessary applications for the embroidery of the designed embroidery must be done correctly.

Parameters required for quality embroidery; a suitable machine, an embroidery needle suitable for the fabric structure, a good quality embroidery thread suitable for the product and needle, a suitable interlining, an experienced operator, the embroidery frequency suitable for the closure of the yarn and a suitable fabric surface to be embroidered. For a good embroidery quality, all of these parameters must be selected correctly.

In this study, the effect of interfacing and machine tension settings on the quality of the embroidery was evaluated. Evaluations were made by subjective method.

2. Theoretical part - literature review

For a literature search was conducted on the study of the parameters affecting the embroidery design and the effects of these parameters on the embroidery quality, although many articles and thesis studies were conducted, no previous research has been conducted on the direct subject of the study.

B. Uygun in his study in 1994, various weights and fabrics in different yarn tension and different machine speeds has been applied with the same type of embroidery. These embroideries were exposed to a force that was below the burst strength of the fabrics and the angles between the embroideries were measured [2].

In 2011, Kuo and his colleagues applied a genetic algorithm to differentiate images from repetitive patterns from images obtained in repetitive patterns, in order to reveal small variations in embroidery surface structure [3].

A. Özmen carried out a research on the realization of the traditional processing techniques and embroidery motifs with the Accurate4 embroidery pattern system in 2012 [4].

C. F. J. Kuo et al. used the image color analysis systems of automatic processing machines in 2012 in order to solve the problems of the lack of manpower in the drawing of embroidery machines and to reduce the duration of drawings [5].

M. Aliabadi and his colleagues aimed to provide experimental techniques in 2013 to reduce noise levels in typical embroidery processes. The experimental techniques developed have been beneficial in analyzing noise pollution and eliminating the hearing problems of employees [6].

In the study carried out in 2014, Z. Şentürk determined the frequency of embroideries applied to various fabrics in accordance with computer-aided embroidery programs [7].

In 2014, J. Zhou et al. investigated the problem of sewing patterns and proposed a controllable sewing scheme strategy for random needle embroidery. This approach has three main features; first, forming a sewing scheme rule which includes low level sewing characteristics; the second is to make a seam environmental graph to model the spatial relationship between the sutures, and the third is to control the different stitching properties using different diffusion processes based on the environmental graph [8].

In 2015, C. Yangshihs et al. investigated an automated analysis system that automates color analysis, pattern shape analysis, and tissue analysis for the Tatami embroidery fabric images. The system automatically reveals Tatami embroidery fabric color, form and texture analysis [9].

In 2016, Y. Juang et al. proposed methods to diagnose and classify defects in embroidered woven fabrics. After mutual discussions with the manufacturers of embroidered woven fabrics using computer-aided embroidery machines, they determined the flaws in embroidered woven fabric patterns [10].

In this work, the thermal comfort properties of the materials forming the jacket are investigated as monolayer and multilayer. The materials were tested as a single layer in first configuration. Then interlinings were fixed to fabrics and tests have been carried out as two layers. Finally, fabrics, interlinings and linings were tested as triple layer. According to the test results, the increase in the number of layers causes the decrease in air and water vapour permeability, and causes increase in the thermal resistance of the material [11].

Sarıçam and Kalaoğlu, depending on woolen fabric and interlining components in suit production; investigated bond strength and bending stiffness of bonded composite structures [12].

3. Embroidery in general

Industrial embroidery machines are the machines that can be processed in computer memory and stored after the necessary adjustments are made. The characteristics of the machines may vary according to their brands and models. Each machine can do the same operation and attach different tools to the machines. The machines are variable according to the number of embroidery heads. The machines available are 1, 4, 12, 15, 18, 45, 68 embroidery head counts. As the head count increases, the head ranges are narrowed if the size of the machine stays same.

Needles for embroidery machines

The sharp rise in diversity of materials in recent years, especially 3-dimensional embroideries embroidery supplies, and covering the skin with a special structure and technical textiles, has raised expectations for embroidery needle with the machine running at high cycles. The choice of needle varies according to the fabric and pattern. For example, fine and precise writing need using fine needle for a high quality and more smooth. Choosing the right needle will prevent some errors in production. At the top of these errors come yarn breaks.

Interlinings used in embroidery machines

Embroidery stitch seams in production, planted to increase the resis-

tance of the material during sewing and materials used to ensure the smoothness of the seam is called interlining. Interlining is an intermediate layer which is attached to the fabric in different ways in order to obtain the appearance, quality and effect expected from the clothing. By adding volume and resistance to the treated fabric, it contributes to the garment such as strengthening during planting, washing and ironing processes. The interlinings are obtained from natural or artificial fibers. It is produced in the form of woven, knitted and nonwoven.

Yarns used in embroidery machines

Yarns that produced exclusively for embroidery machines, with various fiber structure are those differ in color, thickness and brightness. The most important quality parameter of the embroidery is the yarn. A good embroidery yarn needs to have good gloss, softness and elasticity. Soft and flexible yarn passes through the yarn guide and the needle moves during the embroidery process easy and thread breakages are reduced.

Effect of embroidery surface on quality

The characteristics of the surface to be embroidered directly affect other parameters. Depending on the surface to be used, needle, yarn, interlining selection and the frequency of embroidery to be applied are determined. The more appropriate the embroidery the fabric properties, the more uniform embroidery practices are achieved.

Work experience of machine operator

The embroiderer is a person skilled in the art who has his own knowledge and the ability for embroidery using patterns and embroidery techniques on various floors and within a certain period of time. Although the multihead embroidery machines used in the embroidery industry are computer controlled, the machine settings and the surface to be embroidered are laid by the machine operator.

Embroidery frequency (pattern density)

In the pattern, the distance value between the two sills in the stitch-out movements (winding, needle, etc.) determines the frequency of the pattern. When this value decreases, the pattern becomes shorter because of the decrease in the distance between the dips. When the value is increased, the distance will increase and the pattern becomes sparse. The frequency value depends on the yarn used, the fabric, the method and the thickness of the windings. General overall value is "5". When the distance between two sinking is 0.5 mm, the value is considered to be "5". This distance is also generally ideal.

Effect of embroidery machines on quality

As the machines operate at high speed speeds, the adjustment of the yarn tension according to these speeds makes the embroidery more homogenous and therefore smoother.

4. Material and method

4.1. Material

Machine, machine settings, operating conditions, machine operator, used fabric, yarn, needle, interlining, designer, pattern program and studied patterns are effective on embroidery quality. In this study, the interfering and machine settings of the variables affecting the embroidery quality were examined.

The entire application was carried out in the same facility and the same machine operator worked under similar conditions.

Machine

During the application period, Tajima TFGN-1215 embroidery machine model has been studied. In order to examine the effect of the machine tension settings, the embroideries which were obtained by three different applications were examined in a way that was tight, loose and optimum. The embroidery frequencies were kept constant.

Used fabric

Fabric raw material is composed of 50% cotton and 50% PES. It was woven with lattice weave (Pamama weave) and weight was 120 g/m², weft density was 35 threads/cm and warp density was 45 threads/cm.

Thread and needle

In the first stage of the application, the same embroidery was created by using different quality yarns and needle at three different numbers. Based on the embroideries, the yarn which gives good results in each needle is preferred. In this study, 180 dtex 30% metallic PES 70% PA yarn and needle size 80 were used. Yarn bottom color is gray.

240 dtex 100% PES, navy blue thread and needle size 70 were used to examine the change in tension settings. Gray 300 dtex 100% PES sewing thread was used as the lower thread.

Interlining

In the Tab.1 are shows properties of the interlinings for the embroidery application. Five different types of interlining were used in this work.

Tab.1 Properties of used interlinings

No.	Used Interlinings	Weight (g/m²)	Thickness (mm)
1	Single-coat torn interlining	50	0.16
2	Two-coat torn interlining + one–coat of sprayed interlining	100+30	0.44
3	Water-soluble interlining	35	0,23
4	Heat-melting interlining	30	0,22
5	Spun bond interlining	60	0,41

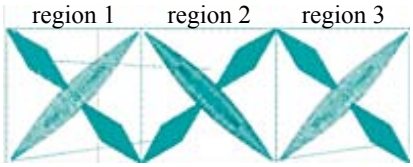

Fig.1 The nature of the pattern and its separation by regions

Pattern

EOS Compucon 2.0 Embroidery design program is designed in the application. The pattern design separated by regions is shown in Fig.1.

4.2. Method

The embroidery sections that make up the application pattern consist of winding and china needle. The earliest examples of Chinese embroidery came off from the Zhou Dynasty (1027 – 221 BC). It is unclear whether this was the origin of embroidery, because Egypt and Northern Europe also had very early examples [13]. In order to have an idea about the importance of the design, the use of different types of embroidery was made together.

In practice, 5 different interlinings were used to determine the effect of interlining on embroidery quality. In this application fabric, machine settings, yarns, patterns and needles are kept constant. The evaluation of the interlining was in two stages, interlinings after leaving the machine and after they were removed.

In order to examine the effect of tension settings on embroidery quality, upper and lower yarn tension settings of machine were evaluated in three different ways.

5. Results and discussion

The results in embroidery quality obtained with five different interlinings are shown in Fig.2-6.

5.1. Evaluation of the embroidery quality with different interlinings - before cleaning

The front and rear view of the single-coat torn interlining before cleaning is shown in Fig.2.

Fig.2 The front and rear embroidery view with the single-coat interlining before cleaning

General attitude and feeling when in contact with the body is soft. The embroidery is light in this state. No puff or shrinkage was observed in the embroidery area; however, shrinkage is observed around the embroidery. After leaving the machine, there may remain interlining residues that are not difficult to clean.

Front and back view of a two-coat torn interlining + one coat of sprayed interlining before cleaning are shown in Fig.3.

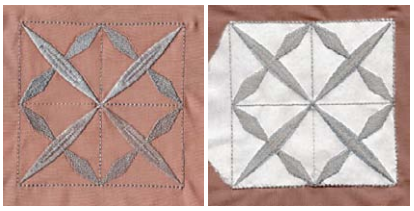

Fig.3 Front and back embroidery view with a two-coat torn interlining + one coat of sprayed interlining before cleaning

Its attitude is hard and it gives an uncomfortable feeling when in contact with the body and has a heavy structure. The embroidery area does not have puff and shrinkage. There are reasonable shrinkage around the embroidery and after leaving the machine, there may remain interlining residues that are not difficult to clean.

The front and rear view of the water-soluble interlining before dissolution are shown as in Fig.4.

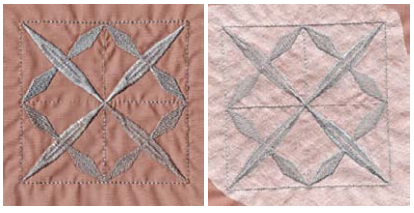

Fig.4 The front and rear embroidery view with the water-soluble interlining before dissolution

Touching and the feeling when in contact with the body are soft and light. In and around the embroidery area, the pots and shrinking are observed. After leaving the machine, interlining remains in the embroidery area and circumference of the area. It is easy to dissolve the interlining by keeping it in warm water.

Front and back view of interlining with heat-melting properties before melting are shown in Fig.5.

Fig.5 Front and back embroidery view with heat-melting interlining before melting

For this interlining; and the feeling of contact when touched by the body is moderate. It gives a feeling of cheapness. The embroidery has a light structure. Puff and shrinkage can be seen in and around the embroidery area, there remains the interlocking in and around the embroidery area and it is possible that the special melting apparatus or devices providing sufficient heat can melt this interlining.

Front and back view of embroidery made with spun bond interlining are shown in Fig.6.

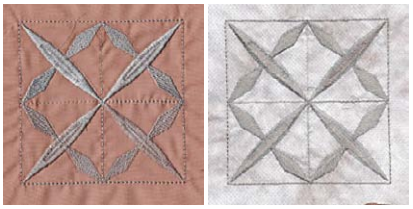

Fig.6 Front and back view of embroidery made with spun bond interlining before cleaning

Embroidery made with this interlining providing soft and comfortable sensation when they touched the body. Embroidery, in this form, has a light structure. In and around the embroidery area, the pits and shrinking are observed. However, it is difficult to clean this type of interlining be-

Fig.7 Back views of embroidery made with different interlinings after cleaning
(1 - single-layer torn, 2 - two-coat torn interlining + one-coat sprayed interlining,
3 - water-soluble interlining, 4 - heat melt interlining, 5 - spunbond nonwoven interlining)

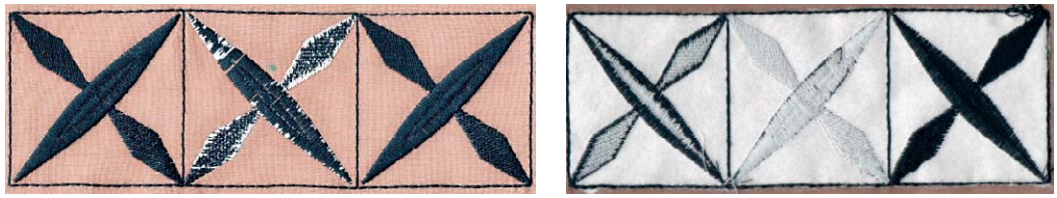

Fig.8 Front and back view of the embroidery in different tension settings
(1 - lower front, 2 - higher front, 3 - required front, 4 - lower back, 5 - higher back,
6 - required back)

cause the spun bond nonwoven seems to be very robust.

5.2. Evaluation of the embroidery quality with different interlinings - after cleaning

The back views of embroidery made with five different interlinings after cleaning are shown in Fig.7.

After cleaning of the interlinings used in embroidery process the quality of manufactured embroideries ware examined. There was no change in touch embroidery made with the single-coat torn interlining. It was easy ripped and cleaned with no difficulty.

There was no change in the attitude of 2 coat torn + 1 coat sprayed interlining after cleaning. It has been torn again. However, it was difficult to completely remove the interlinings in the embroidery area.

After dissolving of water-soluble interlining there was no change in front view, interlining at rear side has been completely cleaned. Dissolution of the interlining affected negatively the embroidery touching. Fabric has gained more hard and cold attitude. For this reason, it is necessary that special cleaning techniques should be applied and softening should be provided.

When the heat melting interlining was removed with heat, the majority of the interlining at the back melted, although there was no change in the appearance on the front face. This melting process is a process that requires additional equipment and mastery. Those who make this process better can achieve melting without or less interlining. This melting process had no negative effect on the embroidery touching, but attitude before melting has given a better sense of comfort in relation to sense after melting.

Spunbond nonwoven interlining removal is a difficult process. Although the embroidery area has a partial cleaning process, some difficulty can be occurred that can interfere with the embroidery area. The scissor is sufficient as an accessory, but it should not be expected to completely remove the interlining.

5.3. Effects of machine tension settings on embroidery quality

Three different machine settings were used in the application (lower tight, required i.e. optimal, upper tight i.e. higher), Fig.8. In this application fabric, interlining, yarns, pattern and needle are kept constant.

First region; worked with upper yarn open, lower tight tension settings. Navy blue top thread and gray color lower thread were used. Thus, the error was observed more clearly. From the front to the good-looking embroidery, however when looked from back the upper thread seems more dominant than the lower thread. In the case of winding type embroidery, the disturbance of this setting does not affect the embroidery quality very much, but puffs in the china needle sections can be observed.

Second region; worked with upper tight, lower open tension settings. The dominant color in the rear view is the lower thread. Since the top is tight, when the amount of yarn coming from the top is not enough in the places where it needs to be processed, lower yarn is raised to the top. Very tight adjustment of the upper thread is a condition that disrupts the quality of the embroidery and is undesirable.

Third region; worked with the required tension settings. When viewed from the top, there is no bottom yarn raised to top and no puff. When viewed from the back it looks balanced. When working with tension settings below or below optimal values, embroideries similar to the appearance in regions 1 and 2 occur.

6. Conclusion

For quality embroidery, the fabric, pattern structure, interlining and machine settings are of great importance as well as needle-thread.

Interlining in embroidery processes is used in every fabric. Sample work in the embroidery for the first time helps

to solve the problems of embroidery quality. Options such as embroidery size, embroidery position, fabric attitude, desired attitude after embroidery should be taken into consideration.

In the embroidery process, the interlining stretched and with the pulley movement which makes movement of the piece to be embroidered over it along the machine. In other words, the embroidery takes the movement of the parts through the interlining. Good tension is another parameter that affects the quality of the embroidery. Unless a good stretching of the interlining during tension of interlining is not provided such that there shall not be any puff, many errors can occur in the finished embroidery.

The embroidery made with single-layer ripped interlining is generally of good quality with soft touch and lightness. It has a feature that can be easily used in making large embroideries. The quality of the embroidery does not deteriorate after the interlining is ripped and removed.

2-coat torn + 1-coat spray interlining has a very hard touch. It also increases the weight significantly in large embroideries. However the quality of the embroidery appearance is quite good. As with the single-layer interlining, the quality of the embroidery was not observed after the interlining was ripped. These interlinings are more suitable for small areas of embroidery.

The embroidery made by melting interlining in water is good in comfort and has a light structure. There were slight shrinkage in and around the embroidery area. These interlinings can be used in all areas of outer wear. The touch of the interlining by melting in the heat is not very hard but does not give hardness to the surface. Nylon bottom surface creates a light, cheap effect. However, after melting interlining with heat, the surface has a much better touch. The melting of the interlining requires skill. Therefore, this work must be done by skilled people. Heat melting interlining can be used in embroidery of large surfaces in clothing. Since the hardness that can be caused by interlining is eliminated, it is also widely used in children's clothing. Especially it is suitable for use on skin contact clothing such as t-shirts.

A soft and good quality embroidery image was obtained using spunbond nonwoven interlining. However, it is very difficult to remove the spunbond nonwoven interlining. It is cut away with the help of scissors. It is not possible to remove the interlining in the embroidery area. Spunbond nonwoven interlinings can be used in the processing of brand logos in products such as shirts. These interlinings are removed only from the surrounding of embroidery. Therefore, the embroidery area looks smooth.

In short, the choice of interlining should be according to the place of use of the product. Interlining is very important to provide ease of use. In the comfort of the clothes, heat melt or water-soluble interlinings may be preferred. Especially considering the sensitivity of the skin of young children, a thin, cotton surface can be stitched under the embroidered area. Even though the interlining in the embroidered area is 100% removed, the yarn density due to frequent needle pricks can irritate the skin.

Each head in the embroidery machine must be adjusted properly. In particular, undesirable quality errors can occur when the tension settings are not optimal. In particular, the strict adjustment of the upper tension to the lower tension causes the bottom thread of the embroidery to rise to the top and therefore the embroidery quality is very low. The opposite of this situation may cause the upper thread to be loose and cause appearance and usage errors.

In order to obtain quality embroidery, only the parameters examined in this study are not sufficient. Each new pattern can create its own problem. In order to solve the problems, the properties of all materials used in making the embroidery should be mastered.

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